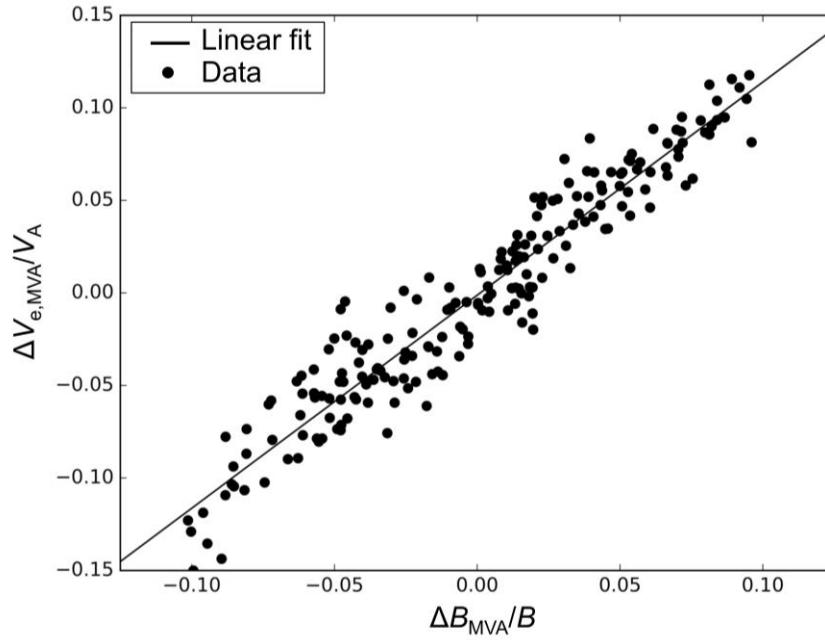
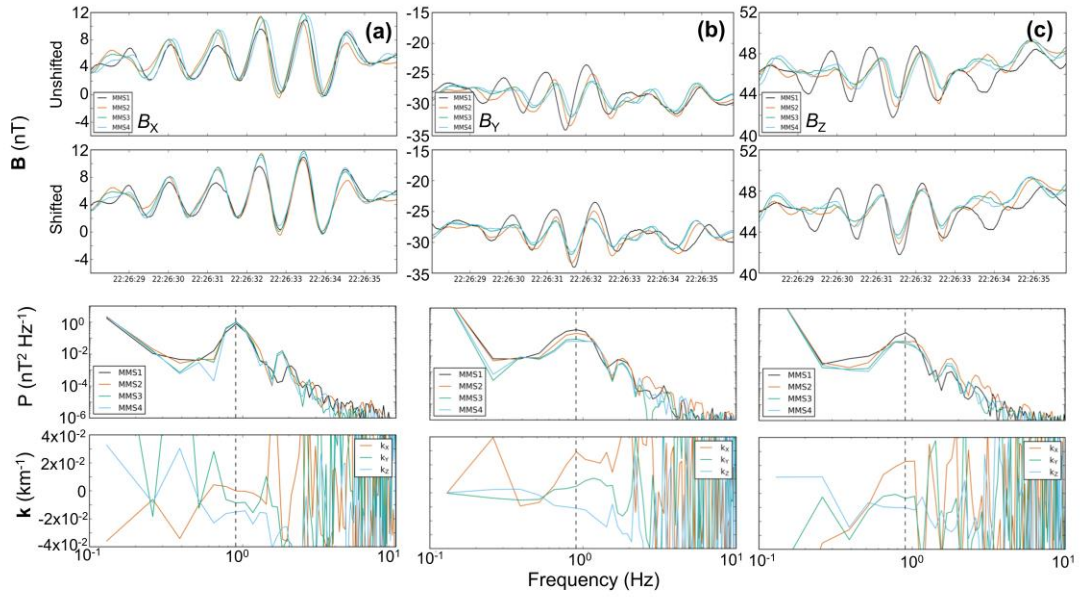


**Supplementary Figure 1. Perpendicular magnetic field fluctuations.** Transverse fluctuations of the MMS-averaged magnetic field components  $\Delta B_1$  and  $\Delta B_2$  are shown for a KAW packet in magnetic coordinates. Hodograms of  $\Delta B_2$  vs.  $\Delta B_1$  for three subintervals of the wave packet indicated a transition from left-handed to right-handed polarization near the center of the packet.



**Supplementary Figure 2. Correlation of velocity and magnetic field fluctuations.**

$\Delta \mathbf{V}_e/V_A$  vs.  $\Delta \mathbf{B}/B$  for transverse fluctuations in the direction corresponding to the minimum variance (MVA) direction of  $\Delta \mathbf{J}$ , i.e.,  $[0.93, 0.32, 0.18]$ . The positive correlation between  $\Delta \mathbf{V}_e$  and  $\Delta \mathbf{B}$  indicated that  $k_{\parallel} < 0$ , i.e., the wave propagated anti-parallel to the local magnetic field. The slope of a linear fit of the fluctuations was near unity ( $1.15 \pm 0.03$ ), indicating that the parallel (with respect to the local magnetic field) wave speed was close to  $V_A$ .  $B = 55 \text{ nT}$  and  $V_A = 380 \text{ km s}^{-1}$  were used for the normalizations of magnetic and velocity fluctuations, respectively.



**Supplementary Figure 3. Phase-differencing of magnetic field fluctuations.** Measured and time-shifted magnetic field, power spectral density, and  $\mathbf{k}$ -vector determined from phase differencing of (a)  $B_x$ , (b)  $B_y$ , and (c)  $B_z$  using MMS3 as a reference spacecraft. The phase difference at spectral density peak of  $\sim 0.9$  Hz was used to shift the data. Different shifts of MMS1 data for different components of the magnetic field vector indicate that this wave packet is not truly planar. Nonetheless, the  $\mathbf{k}$  vectors derived from each indicated  $k_{\perp}\rho_i \sim 1$ .